

THE MINERAL INDUSTRY OF

GREECE

By Harold R. Newman

The mining and metal processing sectors of the economy of Greece were small but important parts of the national economy and were highly concentrated. About 60% of the sector's turnover was handled by five mining companies. Bauxite was the most important of Greek mineral commodities. Other important commodities were chromite, gold, iron, lead, nickel, and zinc. Aluminum was produced from domestic sources of bauxite and alumina and was important in the domestically integrated metal's sector. The steel produced was mostly from imported scrap. Greece was the largest producer of bauxite, magnesium, nickel, and perlite in the European Union (EU).

The industrial mineral sector was more important in the national economy than the metal sector. In 1999, the more important commodities were bentonite, magnesite, and perlite. Privatization efforts were continuing in the magnesite and refractories industries (table 1).

Production of mineral commodities in Greece was closely tied to the export market. Exports of minerals such as bauxite, bentonite, nickel, and perlite made up a major share of total revenues. Although about 50% of the country's minerals were being exported, over the long-term, the sector's significance was slowly lessening. There was a minerals surplus trade balance as more minerals were exported than imported. About 6,000 people worked in the metals and industrial minerals mining sectors and another 6,000 worked at the lignite mines operated by the government-owned Public Power Corporation (PPC). In 1996, the latest year data were available, 100 mines were active, while 270 mines were abandoned (Mining and Metals, February 1999, Technological advancements spur revival in mining sector, accessed April 29, 1999, at URL <http://www.ana.gr/hermes/1999/feb/mining.htm>).

Because northern Greece was thought to contain a significant amount of exploitable mineral resources, it was receiving more attention in regards to exploration activities. In 1999, most activities were directed towards gold. Only a few foreign companies have invested in Greek mines. These companies included TVX Hellas S.A., an affiliate of TVX Gold Inc. of Canada, which bought the Kassandra Mines (the Olympias and the Stratonis deposits) and United Kingdom-based Microfine S.A., which operated mines extracting a rare material, huntite, unique for its flame-retardant properties. The Germany-based Otavi Minen Hellas S.A. operated perlite mines. Selected Greek companies with major equity owners are listed in table 2.

Environmental concerns were the responsibility of the Ministry of Environment, Town Planning, and Public Works. The Government took an active role in programs for the protection of the environment. The general laws enacted by the Government included Law 1360/76 ("Siting Arrangement and Environment") the Presidential Executive Order 1180/81, and Law 1650/86 ("Environmental Protection"), which formed the

basis of the active legislative framework. To comply with the EU's Order 88/609 concerning emission limitations, the Government executed Ministry Decision 58751/2370/15.4.93, which also includes the limits of the main pollutants from electric powerplants.

PPC had projects underway for reducing sulfur dioxide emissions from powerplants in southern Greece, and new electrostatic precipitators were being installed in the lignite powerplant operations in northern Greece. In central Greece, some fuel oil powerplant units were being modified to burn natural gas. The Government's decision to import natural gas from Russia and possibly Algeria was based, in part, on the fact that natural gas burns cleaner than lignite coal. (Black Sea Energy Review, January 3, 1999, Greece—Energy and environment, accessed August 9, 2000, at URL http://www.bsrec.bg/greece/greece_energy.html).

The development of hydroelectric projects included six powerplants under construction offering 625 megawatts of additional capacity to the generating system (Public Power Corporation, [1999], Future developments, accessed August 15, 2000 at URL <http://www.dei.gr/company/develop.htm>).

Aluminium de Grèce S.A., which is a subsidiary of Pechiney of France and the only producer of primary aluminum in Greece, was in the process of completing parts of an investment plan which began in 1996. At its completion, the program will allow for the decrease of production costs by 20% and result in increased productivity. The \$64.3 million program was expected to be completed by yearend 1999. Also, Aluminium de Grèce announced its intention to build an electricity production unit at a total estimated investment of \$1 billion. Two of the reasons that led to the decision were that the energy market will be deregulated in 2000 and that the contract with PPC will expire by 2006 (aluNET International, May 28, 1999, Aluminium de Grèce invades the production of electricity sector, accessed June 3, 1999 at URL <http://www.alunet.net/market/pechiney.htm>).

Bauxite mining operations continued through 1999. Silver & Baryte Ores Mining Co. S.A.'s (S&B) operations, which were formerly owned by Bauxites Parnasse Mining Co. S.A., continued in the Itea area with most of the production exported. S&B also continued operations at Euboea, Helicon, and Parnassos. Delphi-Distomon S.A. continued to produce bauxite, which was sold to Aluminium de Grèce S.A.'s operation at Distomon.

The Kassandra Mines have produced lead, silver, and zinc for more than 30 years. The mines were bought in 1996 by TVX Hellas, with the idea of exploiting the refractory gold ore by incorporating pressure oxidation technology into the ore-processing phase.

In 1998, bankable feasibility studies were completed on the Olympias and the Skouries deposits. During the first 5 years of operation, the combined production of the two deposits were forecast to add about 12,700 kilograms (410,000 ounces) of gold to TVX Hellas's gold production profile at an average cost of below \$80 per ounce net of byproduct credits. In 1999, TVX Hellas instigated a review of the 1998 study and decided to implement dual-processing technologies at Olympias, which combined bio-oxidation and pressure oxidation. At Olympias, the mill was designed with a three-stage grinding circuit followed by differential flotation to produce galena and sphalerite concentrates to be sent to smelting, and a pyrite concentrate to go to the gold recovery plant. An initial bio-oxidation phase at the plant feeds a pressure-oxidation circuit, which is followed by conventional cyanidation. Recoveries from the oxidation circuits were expected to be about 95% (Northern Miner, 1999b).

Royal Gold Inc. (RGI) of the United States announced that its joint-venture Milos project with Goldmax Resources Inc. of Canada was proceeding with the first phase of drilling. RGI reported gold mineralization was encountered in the Amethyst Ridge and East Amethyst zones, which host epithermal quartz veins and stock work zones in a rhyolitic volcanic intrusive complex on the southwestern side of Milos. Following 18,000 meters of reverse-circulation drilling, Barnes Engineering Services of the United States used the multiple-indicator kriging method and a half-cutoff grade to arrive at an oxide resource of 20 million metric tons (Mt) grading 1.43 grams per metric ton (g/t) of gold. By increasing the cutoff grade to 1 gram, the resource shrinks to 8.6 Mt at 2.43 g/t (Northern Miner, 1999a).

General Mining & Metallurgical Co. S.A. (LARCO) was considering restarting some of its idle nickel production capacity in 2000. The plant ran at two-thirds capacity in 1999 owing to the low price of nickel. Following a London Metal Exchange rise in nickel price to above \$7,000 per metric ton, LARCO was considering raising output to normal production capacity of about 18,000 metric tons per year (t/yr) (Metal Bulletin, 1999).

In the industrial minerals sector, Hellenic Mineral Mining Co. S.A. continued asbestos mining operations at the mines at Zidani near Kozani. Most of the various grades of asbestos fibers produced were exported. The fibers are suitable for mixed applications, such as asbestos cement pipes and roofing applications.

Greece was the second largest world producer of bentonite after the United States. Bentonite was extracted from Milos by open pit mining. Mykobar Mining Co. S.A. and S&B are the major producers and accounted for almost all Greek bentonite.

Mykobar's operations had the capacity to produce over 200,000 t/yr while S&B operates a 600,000 t/yr capacity facility. Major applications were iron ore pelletizing, drilling mud, civil engineering applications, foundry applications, and cat litter.

Lava Mining & Quarrying Co. specialized in industrial minerals with production of gypsum from the island of Crete, pozzolan from Milos, and pumice from the island of Yali.

Grecian Magnesite S.A. was a leading magnesite producer in the western world. Its open pit mine was at Yerakini in northern Greece. After mining, the material is processed, beneficiated, and fed into rotary or shaft kilns for conversion to caustic or dead-burned magnesite.

In 1999, the Greek marble industry continued to play a leading role in the international dimension stone market as a result of the marble's production in almost all areas of the country, variety of uses, and many colors (ash, black, brown, green, pink, red, and multicolored). The marble industry was active in the quarrying, processing, and the sale of blocks and finished products.

S&B continued production of natural zeolite in northern Greece. The operation produced five grain sizes of clinoptilolite, which has a high cation exchange capacity owing to its honeycomb crystalline structure.

PPC was the major producer of lignite, which was the predominant fuel in electricity generation in Greece. The company continued exploration in the basins of Amyntaion, Elasson, Florina, Megalopolis, and Ptolemais in 1999. PPC had reserves estimated to be 6.8 billion tons (Gt), from which 4 Gt was estimated to be economically recoverable by open pit mining. Most PPC lignite was produced from the Ptolemais-Amyntaion Basin with lesser amounts from the Megalopolis Basin (Public Power Corporation, [1999], Lignite mines, accessed June 1, 1999, at URL <http://www.dei.gr/company/lmines.htm>).

References Cited

- Metal Bulletin, 1999, Larco mulls restart: Metal Bulletin, no. 8408, September 13, p. 24.
Northern Miner, 1999a, Royal sizes up gold deposit: Northern Miner, v. 85, no. 19, January 5, p. 1.
———1999b, TVX revises study: Northern Miner, v. 85, no. 35, September 25, p. 1.

Major Source of Information

Institute of Geology and Mineral Exploration
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TABLE 1
GREECE: PRODUCTION OF MINERAL COMMODITIES 1/ 2/

(Metric tons unless otherwise specified)

Commodity 3/	1995	1996	1997	1998	1999 e/
METALS					
Aluminum:					
Bauxite	2,200,216	2,451,734	1,876,600	1,823,000 r/	1,850,000
Alumina, Al ₂ O ₃ equivalent	597,620	601,580	615,700 r/	625,000 r/	625,000
Metal:					
Primary	130,361	141,295	132,600	145,900	158,500 4/
Secondary e/	3,000	3,000	3,000	3,000	3,000
Chromite, run-of-mine e/	--	11,725 4/	12,000	12,000	12,000
Iron and steel:					
Iron ore and concentrate, nickeliferous, Fe content e/ 4/	800,000	800,000	700,000	700,000	600,000
Metal:					
Steel, crude	939,170	950,000 e/	1,016,000	1,109,000	1,200,000
Ferroalloys, ferronickel	68,620	71,204	70,000 e/	68,000 e/	68,000
Lead, mine output, Pb content by analysis	20,551	11,541	19,300 e/	18,000 e/	16,000
Manganese:					
Ore, crude:					
Gross weight	9,850	11,000	12,067	10,000	10,000
Mn content	2,130	2,572	2,600 e/	2,500	2,500
Concentrate:					
Gross weight	4,230 r/	3,000 r/ e/	2,910 r/	3,000 r/ e/	3,000
Mn content	2,035	1,440	1,440 r/	1,440 e/	1,440
Nickel, metal, Ni content of ferronickel	17,164	17,801	17,900 r/	15,000 e/	13,500 4/
Silver, mine output, Ag content kilograms	33,000	16,600	35,900 e/	64,500	44,100 4/
Tin, metal, secondary e/	150	150	150	200	200
Zinc, mine output, Zn content by analysis	14,500	13,602	17,800	29,100 r/	18,900 4/
INDUSTRIAL MINERALS					
Asbestos:					
Ore	4,920,650	4,862,799	4,038,076	4,000,000 e/	4,000,000
Processed, fibers	75,003	80,213	63,294	60,000 e/	60,000
Barite:					
Ore, crude	668	671	905	800 e/	800
Concentrate	600	530	742	600 e/	600
Cement, hydraulic e/ thousand tons	14,480 r/	14,700 r/	14,982 4/	15,000 e/	15,000
Clays:					
Bentonite:					
Crude	1,115,119	973,517	942,555	950,000 e/	950,000
Processed	512,000	764,578	572,718	750,000 e/	750,000
Kaolin:					
Crude	68,682	60,453	60,000 e/	60,000 e/	60,000
Processed e/	314 4/	300	300	300	300
Feldspar e/	27,000	60,000	65,000	65,000	60,000
Gypsum and anhydrite	485,353	546,344	662,640	600,000 e/	600,000
Magnesite:					
Crude	565,720	682,346	623,050	650,000 e/	650,000
Dead-burned	69,543	57,438	86,260 e/	70,000 e/	70,000
Caustic-calcined	206,532	120,072	116,775	125,000 e/	125,000
Huntite, crude e/	12,500	13,000 r/	19,422	18,000	18,000
Nitrogen, N content of ammonia	64,900 e/	90,400 e/	82,700	82,000 e/	82,000
Perlite:					
Crude	565,479	598,640	695,917	600,000	600,000
Screened	431,054	417,882	500,714	500,000	500,000
Pozzolan (Santorin earth)	691,722	745,790	766,750	750,000	750,000
Pumice	856,450	867,450	841,646	850,000	850,000
Salt, all types	143,351	147,239	150,000 e/	150,000	150,000
Silica	68,050	86,600	95,730	90,000	90,000
Sodium compounds: e/					
Carbonate	750	750	750	750	750
Sulfate	6,000	6,000	6,000	5,000	5,000
Stone:					
Dolomite	92,920	23,000	90,000 e/	90,000	90,000
Marble cubic meters	379,502	196,669	200,000 e/	200,000	200,000
Flysch	35,434	85,138	90,000 e/	80,000	80,000
Quartz, processed	5,555	6,350	7,500 e/	6,500	6,500

See footnotes at end of table.

TABLE 1--Continued
GREECE: PRODUCTION OF MINERAL COMMODITIES 1/ 2/

(Metric tons unless otherwise specified)

Commodity 3/	1995	1996	1997	1998	1999 e/	
INDUSTRIAL MINERALS--Continued						
Sulfur:						
S content of pyrites	18,737	9,660	10,000 e/	9,500 e/	9,500	
Byproduct: e/						
Natural gas	100,000	105,000	52,000	55,000	55,000	
Petroleum	5,000	10,000	7,600	7,500	7,500	
Total sulfur	124,000	125,000	69,600	72,500	72,000	
Zeolite e/	--	2,000	3,000	4,000	3,000	
MINERAL FUELS AND RELATED MATERIALS						
Coal:						
Lignite	thousand tons	56,533	59,738	56,375 r/	60,400	58,000
Lignite briquets e/		50,000	50,000	50,000	50,000	50,000
Coke, gashouse e/		14,000	15,000	15,000	14,000	14,000
Gas:						
Manufactured, gasworks e/	million cubic meters	16	15	15	15	15
Natural	do.	35	38	43	40 e/	40
Natural gas plant liquids e/	thousand 42-gallon barrels	350	350	350	350	350
Petroleum:						
Crude	do.	3,285	3,738	3,380 e/	3,400 e/	3,400
Refinery products: e/						
Liquefied petroleum gas	do.	5,500	5,000	5,000	5,000	5,000
Gasoline	do.	30,000	30,000	30,000	30,000	30,000
Naphtha	do.	4,500	4,500	4,500	4,500	4,500
Mineral jelly and wax	do.	15	15	15	15	15
Jet fuel	do.	12,000	12,000	12,000	12,000	12,000
Kerosene	do.	150	150	150	150	150
Distillate fuel oil	do.	26,000	26,000	26,000	26,000	26,000
Refinery gas	do.	2,000	2,000	2,000	2,000	2,000
Lubricants	do.	1,000	1,000	1,000	1,000	1,000
Residual fuel oil	do.	36,000	36,000	36,000	36,000	36,000
Bitumen	do.	1,500	1,500	1,500	1,500	1,500
Petroleum coke	do.	500	500	500	500	500
Other	do.	400	400	400	400	400
Refinery fuel and losses	do.	6,000	5,500	5,500	5,500	5,500
Total	do.	126,000 r/	125,000 r/	125,000 r/	125,000 r/	124,565

e/ Estimated. r/ Revised. -- Zero.

1/ Table includes data available through March 2000.

2/ Estimated data are rounded to no more than three significant digits; may not add to totals shown.

3/ In addition to the commodities listed, other crude construction materials are produced, but no basis exists for estimation of production.

4/ Reported figure.

TABLE 2
GREECE: STRUCTURE OF THE MINERAL INDUSTRY IN 1999

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
Alumina	Aluminium de Grèce S.A. (Pechiney of France, 60%)	Distomon, in Boeotia area	640
Aluminum	do.	do.	150
Asbestos	Hellenic Mineral Mining Co. S.A.	Mines at Zidani, near Kozani	100
Barite, BaSO ₄	Silver & Baryte Ores Mining Co. S.A. (Eliopoulos-Kyriakopoulos Group)	Milos Island	1
Bauxite	do.	Mines at Fokis, plants at Fokis and Itea	2,000
Do.	Eleusis Bauxites Mines, S.A. (ELBAUMIN) (National Bank of Greece)	Mines near Drama, Itea, and Fthiotis-Fokis	300
Do.	Delphi-Distomon S.A.; Hellenic Bauxites of Distomon S.A.; Aluminium de Grèce S.A.	Plants in Aghia Marina, Drama, and Itea	400
Do.		Opencast mines at Delphi-Distomon area	500
Bentonite:			
Crude	Mediterranean Bentonite Co. S.A. (Industria Chimica Mineraria S.p.A., Italy)	Surface mines on Milos Island	20

TABLE 2--Continued
GREECE: STRUCTURE OF THE MINERAL INDUSTRY IN 1998

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
Bentonite--Continued:			
Crude--Continued:	Mykobar Mining Co. S.A. (Silver & Baryte Ores Mining Co. S.A.)	Mines at Adamas on Milos Island	180
Do.	Silver & Baryte Ores Mining Co. S.A. (Eliopoulos-Kyriakopoulos Group)	Plants at Adamas on Milos Island	150
Processed	do.	Mines at Adamas on Milos Island	500
		Plant at Vouidia Bay, Milos Island	400
Cement	Halkis Cement Co. S.A.	Micro-Vathi plant, west-central Euboea	3,000
Do.	Halyps Cement S.A. (Ciments Français, France)	Paralia Aspropyrgos plant, Athens	800
Do.	Heracles General Cement Co. S.A. [Industrial Reconstruction Organization (IRO), 69.8%]	Plant at Milaki	1,900
Do.	Titan Cement Co. S.A.	Plant at Volos	4,600
		Elefsis plant, Athens area	400
		Kamari plant, Boeotia	2,600
		Patras plant, northern Peloponnesus	1,900
		Salonica plant, Salonica	1,650
Chromite	Financial-Mining-Industrial and Shipping Corp. (FIMISCO) (IRO)	Tsingeli Mines and plant near Volos	25
Ferrous alloys, ferronickel, Ni content	General Mining & Metallurgical Co. S.A. (LARCO) (IRO)	Larymna metallurgical plant	25
Gold, Au in concentrate	TVX Hellas S.A. (TVX Gold Inc., Canada)	Kassandra Mines, Olympiada	25
Gypsum	Lava Mining & Quarrying Co. S.A.	Altsi deposit, Crete Island	250
Do.	Titan Cement Co. S.A.	do.	280
Lead, mine, Pb in concentrate	TVX Hellas (TVX Gold Inc., Canada)	Kassandra Mines (Olympias; Stratoni) northeastern Chalkidiki	25
Lignite	Public Power Corporation (Government)	Aliveri Mine, Euboea Island	420
		Megalopolis Mine, central Peloponnesus	7,000
		Ptolemais Mine, near Kozani	28,000
Magnesite, concentrate	Viomagn-Fimisco Ltd. (Violignit S.A., 65%; Alpha Ventures, 35%)	Mines at Gerorema and Kakavos, at Mantoudhi, northern Euboea Island	250
Do.	Grecian Magnesite S.A.	Mine and plant at Yerakini, Chalkidiki	200
Manganese, (battery-grade MnO ₂)	Eleusis Bauxite Mines S.A. [National Bank of Greece (OAE)]	Nevrokopi, Drama	10
Natural gas million cubic meters per day	Public Petroleum Corporation (Government)	Prinos offshore gasfield and oilfield, east of Thasos Island	125
Nickel, ore	General Mining & Metallurgical Co. S.A. (LARCO) (IRO)	Agios Ioannis Mines near Larymna	500
		Mines on Euboea Island	2,500
Perlite	Silver & Baryte Ores Mining Co. S.A. (Eliopoulos-Kyriakopoulos Group)	Mines on Kos and Milos Islands	300
Do.	Otavi Minen Hellas S.A. (Otavi Minen AG, Germany)	Plant at Pireaus	
Do.	Bouras Co.	Milos Island	150
Do.		Kos Island	50
Petroleum, refined 42-gallon barrels per day	Hellenic Aspropyrgos Refinery S.A.	Aspropyrgos	95,000
Do.	Motor Oil (Hellas) Corinth Refineries, S.A.	Aghii Theodori, Corinth	140,000
Do.	Petrola Hellas S.A.	Eleusis	100,000
Do.	Thessaloniki Refining Co. A.E.	Thessaloniki	76,000
Pozzolan (Santorin earth)	Lava Mining & Quarrying Co. (Heracles General Cement Co. S.A.)	Quarries in Milos Island	350
Do.	Titan Cement Co. S.A.	do.	300
Steel, crude	Halyvourgia Thessalias S.A. [a subsidiary of Manassis Bros. and Voyatzis S.A. (65%); the balance (35%) owned by state-owned National Investment Bank for Industrial Development (NIBID)]	Steelworks at Volos (operates two 35-metric-ton electric arc furnaces)	1,500
Do.	Halyvourgiki, Inc.	Steelworks at Eleusis (three 100-metric-ton electric arc furnaces)	300
Do.	Helleniki Halivourgia S.A.	Steelworks at Aspropyrgos (two 55-metric-ton electric furnaces)	400
Do.	Sidenor S.A. (also known as Halivourgia Voriou Ellados S.A.)	Steelworks at Nea Magnesia, near Thessaloniki (two 55-metric-ton and two 30-metric-ton electric arc furnaces)	350
			350
Zeolite	Silver & Baryte Mining Co. S.A. (Eliopoulos-Kyriakopoulos Group)	Mine at Pandalofos	100
		Plant at Ritsona	
Zinc, mine, Zn in concentrate	TVX Hellas S.A. (TVX Gold Inc., Canada)	Kassandra Mines (Olympias, Stratoni) northeastern Chalkidiki	25